EXCHANGE DECOUPLED COBALT/NOBLE METAL PERPENDICULAR RECORDING MEDIA

BACKGROUND OF THE INVENTION

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[0001] This application is based on provisional patent application Serial No. 60/258,790, filed December 20, 2000.

1. Field of the Invention:

[0002] The present invention generally relates to magnetic recording media such as for a computer disc drive, and more particularly to an exchange decoupled Cobalt/noble metal perpendicular recording medium.

2. Background of the Invention:

[0003] Most modern information storage systems depend on magnetic recording due to its reliability, low cost, and high storage capacity. The primary elements of a magnetic recording system are the recording medium and the read/write head. Magnetic discs with magnetizable media are used for data storage in almost all computer systems. Various modeling and simulations have suggested that perpendicular recording (in which the medium is magnetized with a direction perpendicular to the surface of the disc, that is, in the direction of thickness thereof) is superior to conventional longitudinal recording due to various reasons, including larger optimal medium thickness, better write field efficiency, less demagnetizing fields from the stored bit pattern, etc. As the longitudinal magnetic recording technology reaches its limit in the areal density due to the lower thermal stability, perpendicular magnetic recording possesses the potential to a higher recording density. The larger perpendicular anisotropy and high remanence squareness of the Co(X)/noble metal (X = B, Cr, and etc.) multilayers suggest that these thin films

are promising candidates for perpendicular magnetic recording. Doping nonmagnetic materials such as Chromium (Cr) or Boron (B) into a Cobalt (Co) layer for the Co(X)/noble metal multilayers can reduce intergranular exchange coupling and result in lower medium noise. However, the earlier studies of CoB/Pd multilayers showed that the initial CoB layers were continuous. Therefore, it could provide a source for transition media noise, resulting in lower signal-to-noise recording.

[0004] It is therefore an object of the present invention to provide a magnetic recording material for a perpendicular recording medium having improved intergranular exchange decoupling.

[0005] It is a further object of the present invention to provide a perpendicular magnetic recording medium having lower medium noise and resultant higher signal to noise recording.

[0006] It is a still further object of the present invention to provide a graded Cobalt/noble metal bilayer perpendicular recording material having alternating layers of a Cobalt alloy and a noble metal.

SUMMARY OF INVENTION

[0007] The above and other objects, features and advantages of the present invention are attained by a magnetic recording medium having a substrate, a magnetic interlayer and a layer of magnetic recording material thereon, the magnetic recording material comprising a plurality of bilayers having a Cobalt alloy and a noble metal.

[0008] In an alternate embodiment, the magnetic recording medium comprises a substrate, a soft magnetic underlayer, a paramagnetic layer and a perpendicular recording material including alternating layers of a Cobalt alloy and a noble metal.

[0009] In a further embodiment, the magnetic recording medium comprises a substrate, a soft magnetic underlayer, and a graded magnetic recording material including alternating layers of a Cobalt alloy and a noble metal.

[0010] The initial growth region is graded, such that this initial film is paramagnetic at room temperature and does not exchange link neighboring grains. Ideally, the graded region has identical structure to the subsequent magnetic multilayer. This could be accomplished by changing the magnetic alloy CoX such that this alloy by itself becomes paramagnetic, e.g., $CoCr_{40}$. Another implementation of this idea is to drop the thickness of the CoX layer low enough, so that the ferromagnetic Curie temperature of this (CoX/Pd)x N multilayer drops below room temperature, thereby also rendering this initial region paramagnetic.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Various other objects, features and advantages of the present invention will become readily apparent by reading the following description in conjunction with the drawings, which are shown by way of example only, wherein:

[0012] Figure 1 is a cross-sectional diagram of a perpendicular magnetic recording material manufactured according to the present invention;

[0013] Figure 2 shows a schematic cross-sectional representation of the graded magnetic recording material layers according to the present invention; and

[0014] Figure 3 is a graphical representation of a polar MOKE loop of the Cobalt alloy/noble metal multi-layer film produced according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Referring now to the drawings in detail there is shown in Figure 1 a cross-sectional representation of a magnetic recording medium 10 manufactured according to the present invention. A perpendicular magnetic recording medium such as a computer disc, comprises a substrate 13 upon which is deposited a soft magnetic underlayer 16 and then the graded Cobalt/noble metal perpendicular recording material 19 of the present invention. If desired, a 2-5 nm thick adhesion layer or magnetic interlayer 20 may be provided between the substrate 13 and the soft magnetic underlayer 16, which adhesion layer may comprise tantalum. The soft magnetic underlayer 16 may comprise a laminated radially textured soft magnetic underlayer manufactured according to the teaching of applicant's co-pending application Serial No. 10/003,363 filed on November 15, 2001, which application is assigned to the present assignee herein, and is hereby incorporated by reference herein in its entirety. By way of brief explanation the soft magnetic underlayer 16 comprises an amorphous iron-Cobalt-boron alloy layer with tantalum layer applied to a total thickness of about 240nm. The soft magnetic underlayers are applied by sputtering techniques, which are well known to those skilled in the art.

[0016] The perpendicular magnetic recording material preferably comprises a Cobalt alloy (Co(X))having alternate layers of a noble metal. The Cobalt is alloyed with one or more of the group comprising boron (B), chromium (Cr), Tantalum (Ta), Francium (Fr), Platinum (Pt), Tungsten (W), Manganese (Mn), Molybdenum (Mo), Ruthenium (Ru), Silicon (Si), Nickel (Ni), Copper (Cu), or Gold (Ag), whereas the noble metal preferably comprises palladium (Pd) or platinum (Pt). In an alternate embodiment, the perpendicular magnetic material comprises graded bilayers of the Co(X)/noble metal

multi-layers. In the embodiment shown in Figure 2, the perpendicular magnetic recording material 19 comprises an initial nonmagnetic or paramagnetic 22 layer and a final perpendicular recording layer 25.

[0017] The initial paramagnetic material layer 22 preferably comprises a relatively very thin layer 28 of the Cobalt alloy, on the order of <1.5Å. In this embodiment there are three such layers of the Cobalt alloy 28 which alternate with a palladium layer 31 which has a thickness on the order of about 1nm. By the use of the relatively thin Cobalt alloy, the thickness is low enough such that the magnetic Curie temperature of the Cobalt alloy drops below room temperature, which renders this initial region paramagnetic. In this manner magnetic coupling between the layers 28 is prevented so as to increase the magnetic properties of the perpendicular recording media and to increase signal to noise ratio.

[0018] The final Cobalt alloy/noble recording metal multi-layers 25 are applied such that the individual Cobalt alloy layers 34 are about 2-6 Å thick, generally about 3 Å, and the noble metal layers 37 are approximately 8-15 Å in thickness. In this embodiment the magnetic recording material 25 is applied in a range of 8-20 layers and generally 15 layers. That is, after the initial paramagnetic layers 22 are applied, about 15 bilayers of the Cobalt alloy/noble metal are applied, the Cobalt alloy having at thickness of about 3 Å and the noble metal being a thickness of about 1nm.

[0019] Depending upon the desired magnetic recording properties, the magnetic material layers 25 number between 8-20. This produces a low noise perpendicular magnetic recording medium having the desired magnetic properties, such as those shown in the polar MOKE loop of Figure 3.

[0020] By providing the initial paramagnetic layers 22, the layers are exchanged decoupled such that there is no magnetic coupling between neighboring grains of the Cobalt alloy. The grading of the initial growth region makes this initial film paramagnetic at room temperature. As shown in Figure 3 the coercivity of the multi-layer deposited with initial graded bilayers is enhanced. Furthermore as shown in the MOKE loop, as coercivity increases also the coercivity slope increases, indicating a higher degree of exchange decoupling.

[0021] While specific embodiments of the invention have been shown in the drawings and described in detail, it will be appreciated by those skilled in the art that various modifications and alterations would be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of the invention which is to be given the full breadth of the appended claims and in any and all equivalents thereof.